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Alberta Government/Industry
Acid Deposition Research Program

Fifth Annual Report

April 1, 1987 to March 31, 1988

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In Perspective

What level of acid-forming emissions can the Alberta environment tolerate safely? Is the health of people being affected? Is agricultural production adversely influenced by acid-gas emissions? These are some of the important questions and concerns which continue to generate debate and a variety of answers. Environmental purists might wish that no emissions be released. Others question the cost to society of raising Alberta's industrial recovery levels, even by 0.1%, from the already stringent level of 97.3%.

Who is right? What are the most practicable control measures? What environmental management policies should we have?

The Acid Deposition Research Program (ADRP) is working towards establishing a sound, *scientific* basis that will help answer these questions. Through research programs such as the ADRP more knowledge will be gained on how the protection of our environment and an industrialized society can be compatible goals. This scientific information can then be used to assist in establishing both short-term and long-term environmental policies in Alberta. This scientific base will also be shared with other scientists and countries concerned with the same questions.

What are the ADRP's Priorities?

Now going into its sixth year, the ADRP is an $11-million undertaking by the Province of Alberta, the Canadian Petroleum Association, Alberta's electrical utilities and the Energy Resources Conservation Board. The ADRP was formed in 1983 as the result of more than 10 years of work to study and address the environmental consequences of acid-forming gases on Alberta's environment.

The initial impetus came from the Alberta Petroleum Industry, Government Environmental Committee (APIGEC) which subsequently formed SCAGE – the Steering Committee on Acid Gases in the Environment – in 1979.

SCAGE reviewed existing information on acid-forming emissions, determined the extent of knowledge deficiencies, recommended research projects and emphasized the importance of developing an ecological monitoring strategy. The ADRP was formed in 1983 on this foundation and proceeded to define research priorities more clearly with the input of the international scientific community, industry, government and the public.

The ADRP's research programs were designed and continue to be carefully monitored and guided by two internationally recognized groups of scientists: one in human health; the other specializing in air, land and water systems. These impartial Scientific Advisory Boards directed the ADRP to two principal gas groups -- oxides of sulphur (SO_x) and oxides of nitrogen (NO_x) – with respect to the environment or biophysical areas. In addition, in the area of human health, they recommended a controlled medical diagnostic review, completed in 1986, to address the health concerns of residents in a southwestern Alberta community living in the proximity of a sour gas plant.

This unique integration of scientific expertise in the biophysical and human health areas is a distinctive feature of the ADRP. The basic assumption behind this approach is that all components of ecosystems are interrelated. Thus, it is only by understanding the processes within, between and among the human and biological systems that researchers can hope to fully assess the impacts of acid deposition.

The ADRP is now working toward the biophysical research Critical Point I, which is expected to be completed by the summer of 1988. Critical Point I is the stage at which the ADRP and its scientific advisors will look at the first-phase research findings and determine what type of further research, if any, is required.

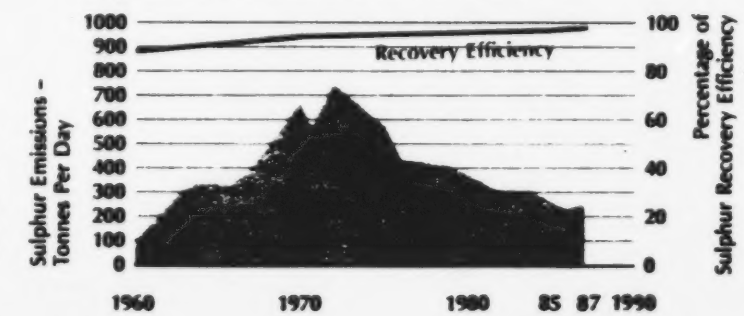
What [illegible]

World wide the processing and burning of fossil fuels produces sulphur and nitrogen oxide by-products. In the atmosphere sulphur dioxide and nitrogen oxides are transformed chemically to sulphuric acid and nitric acid. These two acids can fall to earth as wet depositions in rain, snow, sleet or hail. Through another process, dry deposition, these oxides fall to the earth and can combine with surface moisture to form acids. (Acid deposition is a broader term than acid rain, but the two are often used day-to-day interchangeably.) The key question researchers are investigating is what environmental changes, if any, do the current atmospheric levels produce.

In Alberta, the major sources of sulphur oxides are natural gas processing and oil sands plants and coal-fired power plants. These are primary industries in Alberta and integral to the province's economic structure. The major sources of nitrogen oxides are highways, and urban centres and industrial activities — ranging from the operations of the petroleum industry to electric utilities, fertilizer, cement, chemical and pulp and paper industries.

Alberta's industrial operations related to oil and gas, coal and utilities are governed by regulations which are among the world's most stringent, and the accompanying graph shows that sulphur dioxide emissions have been reduced significantly over past years. Yet, industry and government are continuing to take a proactive approach with respect to acid-forming gases. The scientific base provided by programs such as the ADRP will further foster sound environmental management in Alberta.

Sulphur Emissions and Recovery Efficiency



This graph, provided by the Energy Resources Conservation Board, shows the reduced levels of sulphur emissions in Alberta within the last decade.

Acid Deposition Research Program

Objectives

1. To provide a comprehensive understanding of the effects and consequences of acid-forming gases on the environment.

2. To provide a scientific basis for sound, long-term environmental management and regulatory control with respect to acid-forming gases.

3. To disseminate such information among members, to the public and to government bodies.

4. To undertake any research deemed appropriate.

5. To encourage and include opportunities for public representation in the ADRP.

Membership and Percentage Participation

Members	Percentage Participation for Voting and Funding
The Minister of Environment	50.00
Canadian Petroleum Association	34.60
Energy Resources Conservation Board	10.00
Utilities Group	5.40
- TransAlta Utilities Corporation	
- Alberta Power Limited	
- The City of Edmonton	
Public Member	—
TOTAL	**100.00%**

Members Committee Representatives 1987-88

Ken R. Smith (Co-Chairman)
Assistant Deputy Minister
Alberta Environment

Ron L. Findlay (Co-Chairman)
Manager, Environmental Affairs and Safety
Amoco Canada Petroleum Co. Ltd.
Canadian Petroleum Association

Douglas Bruchet (Treasurer)
Manager, Environmental and Socio-Economic Development
Canadian Petroleum Association

Dr. Cornelius (Casey) G. Van Teeling (Secretary)
Alberta Environment

Ed R. Brushett
Manager, Environment Protection
Energy Resources Conservation Board

Dr. John Railton
Special Projects Manager
Monenco Consultants Limited
Utilities Group Representative

Ed A. Collom
Environmental Health
Alberta Community and Occupational Health

Dr. H. Percy Sims (Special Advisor)
Alberta Environment

Dr. Harby S. Sandhu (Special Advisor)
Alberta Environment

Moderator Public Advisory Board:
Susie Washington

Program Manager:
Dr. Ron Wallace

Communications Co-ordinator:
Jean L. Andryszyn

Members' Committee Report

The Acid Deposition Research Program is now within three months of reaching a major milestone. By the end of July, 1988 a team of more than 50 scientists will have completed some of the world's most advanced research on acid deposition — right here in Alberta.

During this past fiscal year, we have directed our resources — both financial and manpower — towards the successful achievement of "Critical Point 1* " in our biophysical research. Because of the dedication and commitment of our scientists and our Scientific Advisory Board, we are on schedule and on budget in this $5.3 million research program.

For their efforts to this end, we extend our thanks to Principal Investigator Dr. Allan Legge who leads the university-private sector team carrying out the research; to Dr. Sagar Krupa, chairman of the Scientific Advisory Board; and to the scientists on that Board. While the Members' Committee represents the financial sponsors of this ambitious program, we must also recognize Alberta Environment, the Canadian Petroleum Association, the Energy Resources Conservation Board and Alberta's utilities for the long-term funding commitment they have made to this program.

* Critical Point 1 is a decision point. Decisions on further scientific work will be based upon the conclusions and recommendations of this initial phase.

The Goals of Research

The scientists in our biophysical program are working towards answering these two questions – specific to Alberta:

1. At the present time are there environmental problems with acidic deposition on Alberta's crops, forests, soils, streams and lakes?
2. If not, where, when and under what conditions will such effects occur?

In November, 1987 the ADRP was able to provide the public and scientific communities with reports representing two of the four major components in this biophysical work: an 11-volume world literature review, and a four-volume emission source inventory for Alberta. (See Special Report, Biophysical Research p. 8 for more details on program strategy.)

According to a member of the Scientific Advisory Board, Dr. Jim Lodge, a consultant in atmospheric chemistry and editor of *Atmospheric Environment*, the ADRP's world literature review represents a fundamental achievement in science. For those in the scientific community involved in acid deposition and related research, this work will be an invaluable resource. Contained in this 11-volume, 1,300-page world literature review is a unique overview of scientific work done world wide on the topic of acidic deposition. The reviews provided the ADRP's scientists with an under-

standing of where, when and under what conditions adverse ecological effects have been observed by others. The reviews have also made initial obervations on how this worldwide information relates to Alberta's specific environmental conditions.

The four-volume emission source inventory is also a significant accomplishment. This work identifies predominant sources and the rates of emission of sulphur dioxide (SO_2) and nitrogen oxides (NO_x) in Alberta. The sources include licensed industrial plants and facilities, urban centres, and frequently travelled highways. Previous provincial inventories were not of sufficient detail to permit the investigation of specific regions within Alberta. The inventory is also the most thorough done in Canada and will undoubtedly benefit future research in the field.

Demand for the results of both of these works has been exceptional. Within three months, first printings (500 copies of each volume) of both of the world literature review and the emission source inventory have been distributed, free-of-charge, to Alberta libraries, University libraries Canada-wide, and to those individuals, scientists and research bodies nationally and internationally who have requested the reports.

Adhering to Fundamentals

In 1983, through a combination of scientific and public input, the ADRP's program took shape. We were advised by some of the world's recognized authorities — who obtained input from Albertans — to direct our research into two main areas: human health and biophysical (land, air and water).

In the human health area, the public and scientific advisors identified the 20-year health controversy in Pincher Creek, Alberta as a priority for the ADRP. This work* was completed in 1985-86. (Our 1986-87 annual report summarizes the results of this study.) This year the researchers, following the recommendation of the Scientific Advisory Board, conducted a further analysis of selenium data gathered during the fieldwork. This work is now being peer reviewed by the SAB and the results will be made available to the public by the summer of 1988. In addition, last year we reported the results of a feasibility study into occupational

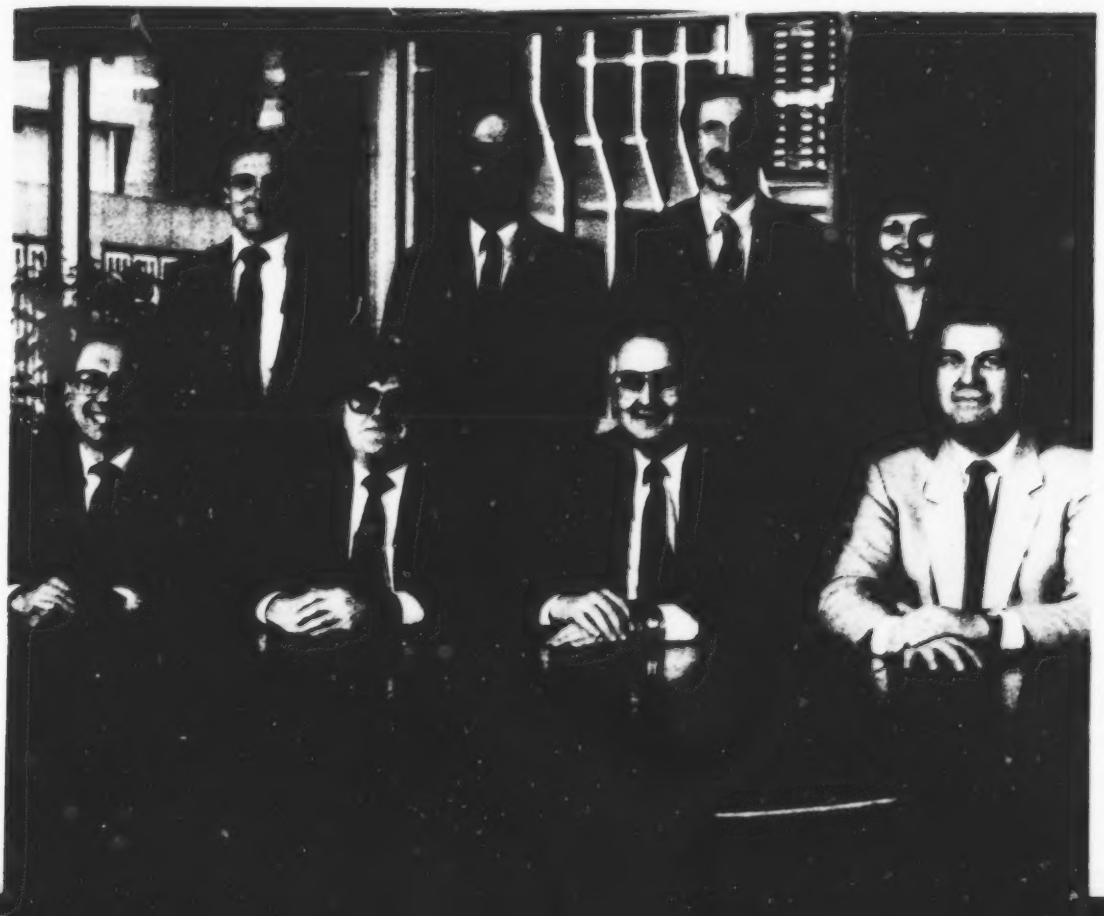
* The $3.7 million Southwest Alberta Medical Diagnostic Review is one of the largest community health studies ever undertaken in Canada. Fortunately, the study reassured residents of this southwestern community that their community was healthy.

health. The proposal for further research has now been referred to the ADRP's Technical Research Advisory Committee on Human Health.

In the biophysical area, the scientific advisors directed the ADRP to focus on two principal gas groups, oxides of sulphur (SO_x) and oxides of nitrogen (NO_x).

The scientific advisors' jobs, though, were not over at identification of priorities. Through all phases of research, the Scientific Advisory Boards (SABs) provide planning expertise, direction and evaluation of the scientific work in both the human health and biophysical areas. These SABs demanded and received assurance from the ARDP that the science would in no way be influenced by the funding members.

By the time we reach Critical Point 1 in our biophysical research this summer, the SAB (see p. 17) will have peer reviewed the final report and made its conclusions and recommendations. Because of the rigorous scientific procedures we have in place, we are confident of the credibility and world-class calibre of the ARDP's research.



Science is Not the Only Priority

In all of its work, the ADRP has endeavored to maintain an atmosphere of openness and public accountability. In keeping with two objectives stated in the Charter, we have put a priority on public involvement and communication of information.

Following an independent review conducted in 1987, the Public Advisory Board (PAB) was re-established and expanded. An independent moderator, Susie Washington, was appointed. She has extensive experience in issue identification, facilitation and communications in the environmental field. (See Special Report Communications, p. 15.)

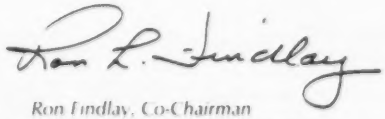
The Members' Committee of the ADRP is most appreciative of the advice and suggestions — particularly in the area of communications — the Public Advisory Board has offered to date. We look forward to a strong working relationship with the Board through to the conclusion of the program.

A public opinion poll, conducted in March 1988, confirmed that significant numbers of Albertans — of all ages and occupations, and in all areas of Alberta — are definitely interested in being advised of the results of this research. In fact, 91% of Albertans expressed high levels of interest in obtaining the results.

With the achievement of Critical Point 1, the science will be in place, but another major challenge will be left. That challenge is to explain the results to Albertans so they can, on the basis of scientific information, determine long-term environmental management policies for our province. The coming 1988-89 fiscal year offers an opportunity for Albertans to be among the world's leaders in this environmental field.

On Behalf of the Members' Committee

Ken Smith, Co-Chairman
Assistant Deputy Minister
Alberta Environment



Ron Findlay, Co-Chairman
Canadian Petroleum Association

The Members Committee of the Acid Deposition Research Program: (front row, left to right) **Ed Brushett,** Energy Resources Conservation Board; **Ken Smith,** Government co-chairman, Alberta Environment; **Ron Findlay,** industry co-chairman, Canadian Petroleum Association; **Douglas Bruchet,** Canadian Petroleum Association; (back row, left to right) **Dr. Percy Sims,** Alberta Environment; **Dr. Casey Van Teeling,** Alberta Environment; **Dr. Ron Wallace,** program manager; and **Jean Andryiszyn,** communications co-ordinator. Not pictured: **Dr. John Railton,** utilities representative; **Ed Collom,** Alberta Community and Occupational Health; and **Dr. Harby Sandhu,** special advisor.

Special Report – Biophysical Research

During the 1987-88 fiscal year, two major aspects of the scientific work for the Acid Deposition Research Program were completed, bringing scientists within months of answering major questions about acid rain in Alberta.

The completion of a comprehensive analysis of the world literature on the effects of acidic and acidifying pollutants (oxides of sulphur and nitrogen) on the environment, and the completion of a detailed emission source inventory of such oxides for Alberta are two points of a four-point strategy in achieving the ADRP's objectives.

This $5.3 million component of the ADRP, was designed to answer two main questions:

1. At the present time are there environmental problems with acidic deposition on Alberta's crops, forests, soils, streams and lakes?
2. If not, where, when and under what conditions will such effects occur?

To answer these questions, in 1985 the ADRP awarded a contract to a study team led by the University of Calgary's Kananaskis Centre for Environmental Research. The ADRP also created a Science Advisory Board (SAB) consisting of 10 internationally renowned scientists representing all aspects of the study. The SAB oversees the content and quality of the research being conducted by the study team.

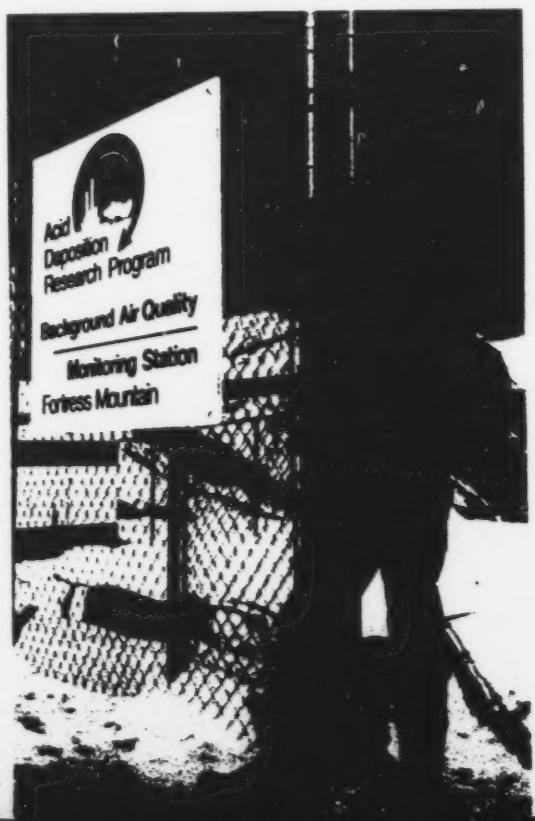
There are four components to the ADRP's strategy for this research:

1. **The world literature reviews** form a data base of studies done world wide on acid deposition. A unique feature of these reviews is the emphasis on cause-effect relationships, i.e. how much and what type of a given pollutant must be present, and how long must it be present before an effect is seen. Mathematical relationships are established between stress and response.

The 11-volume, 1,300-page world literature review has provided the ADRP's scientists with an understanding of where, when and under what conditions adverse ecological effects have been observed by others. The reviews have also made initial observations on how the worldwide information relates to Alberta's specific environmental conditions.

2. **The emission inventory** catalogues all major sources of NO_x and SO_x emissions in Alberta.

The sources include licensed industrial plants and facilities, urban centres, and frequently travelled highways. Previous provincial inventories have not been of sufficient detail to permit the investigation of specific regions within Alberta.



Dr. Allan Legge, principal investigator for the ADRP's biophysical research program, leads a university-private sector team.

3. **Source characterization** measures and describes Alberta's air quality — which has never been done before. The measurement and description of Alberta's air involves looking at its "background quality" (Fortress Mountain) and also the quality of air in locations known to be influenced by industrial emissions, urban activity and traffic (two sites at Crossfield). The data-gathering phase is now complete and analysis is underway.

4. **"Modelling" or creation of scenarios** is now underway. Models* are being used to interpret the potential for effects, or where and when effects might occur. To compensate for uncertainty the scientists will look at certain scenarios (estimating, overestimating, underestimating) in selected regions throughout Alberta. The regions used have been identified as sensitive to acidic deposition and two additional regions have been identified as future expansion areas for increased emissions.

* A model can be described as (in this case) a mathematical expression of a situation. When the raw data collected for each variable of the model is fed in, the model yields a probable result, or effect, of those conditions.

2

1

A subcommittee of the ADRP's Science Advisory Board reviews the initial modelling strategy. Pictured from left to right: **Dr. James P. Lodge,** consultant in atmospheric chemistry and editor of the journal *Atmospheric Environment*, Colorado; **Dr. Ronald N. Kickert,** consultant in ecological modelling, Oregon; (standing) **Dr. Sagar V. Krupa,** science coordinator and chairman of the SAB, professor of plant pathology, University of Minnesota; and **Dr. Herbert C. Jones,** Chief, fisheries and aquatic ecology branch, division of air and water resources, Tennessee Valley Authority.

2

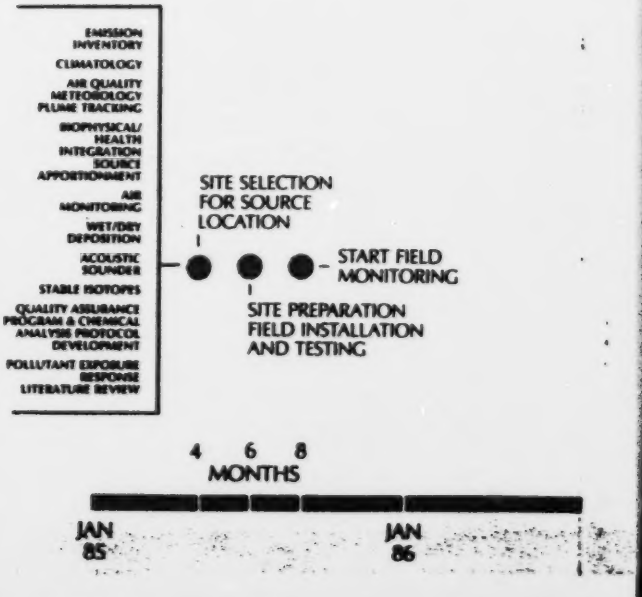
Laying the conduit for air and electrical lines from the air monitoring station to the remote tower supporting the KAP Sampler

In creating the scenarios the scientists will use data on wheat, alfalfa, lodgepole pine and jackpine, as well as data on soils and waters known to be sensitive. Regional scale responses will be studied.

"The ADRP is unique in the sense that a single team of scientists was asked to examine all aspects of acidic deposition and environmental concern," according to Dr. Sagar Krupa, chairman of the SAB and professor, Department of Plant Pathology, University of Minnesota.

"In other words, the study team consists of experts who can research many factors; ranging from pollutant emissions to their transport

ADRP: Biophysical Research Program to Critical Point 1



and chemical reactions in the air, to the responses of crops, forests, soils and waters. In contrast to this complete approach, other study programs, as in the United States, have divided similar research into a number of pieces. In other programs, research on each component is funded by different agencies leading to a lack of strong co-ordination among scientists.

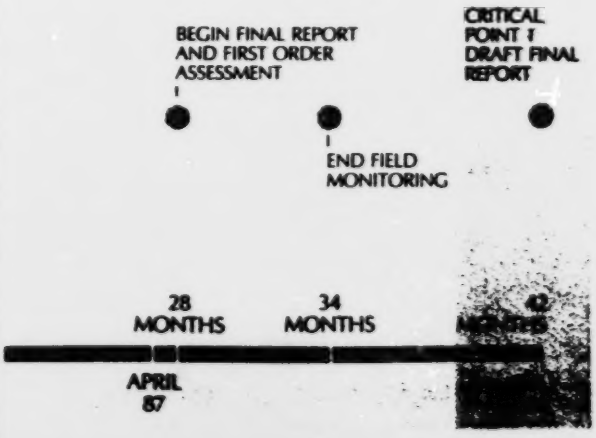
"With the world literature review and the emission source inventory, together with the air quality information we've gathered since 1985, the ADRP is in the enviable position of having one of the most complete and high quality data sets in the world for this kind of research."

The Biophysical Research Team

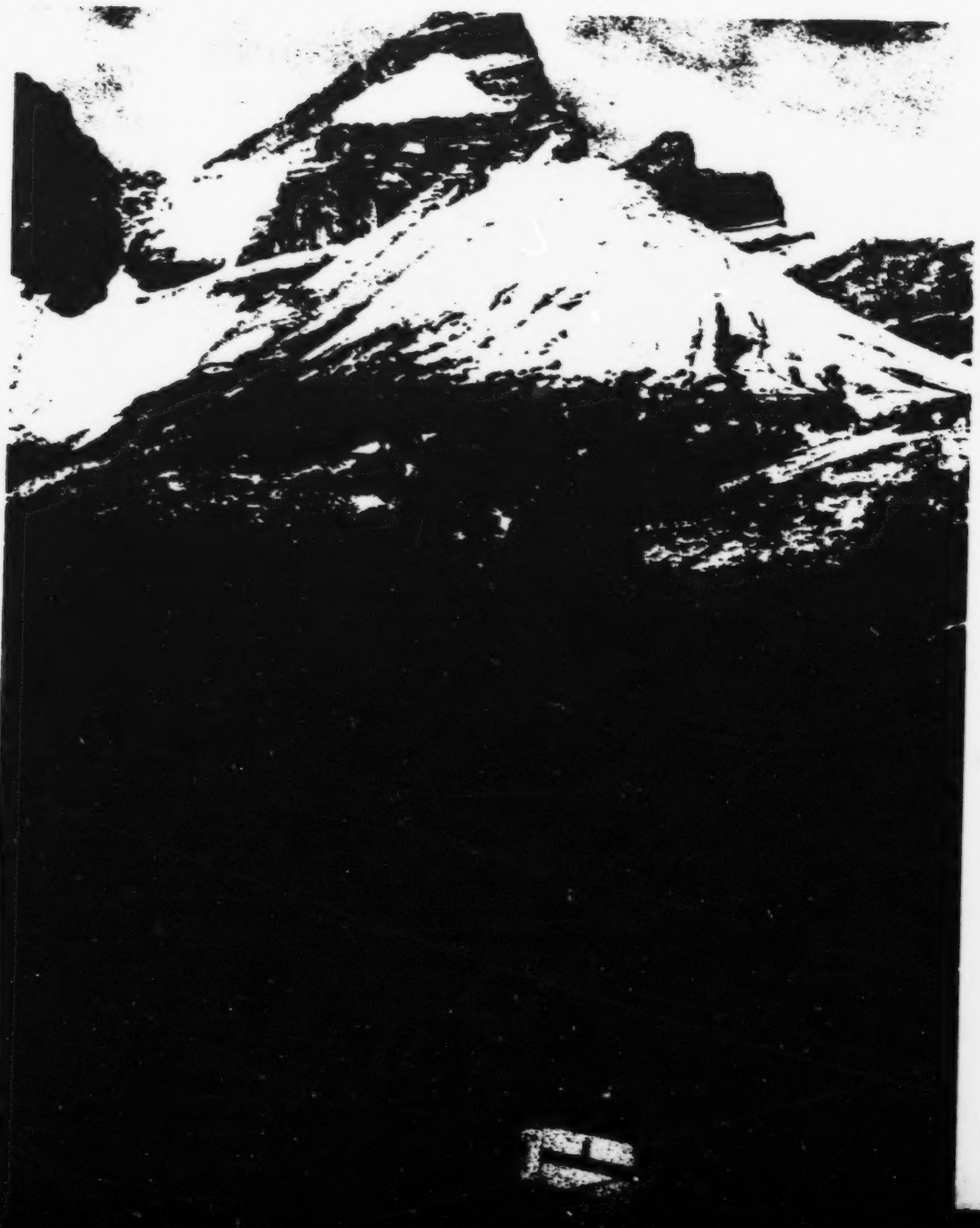
The biophysical research contract was awarded in January, 1985 to a university-private sector team headed by the Kananaskis Centre for Environmental Research of the University of Calgary. The Principal Investigator is Dr. Allan Legge.

The research contract involves more than 50 professional and technical people. In addition to the resources of the Kananaskis Centre, the scientific expertise of individuals from these organizations and companies has been retained to assist the ADRP:

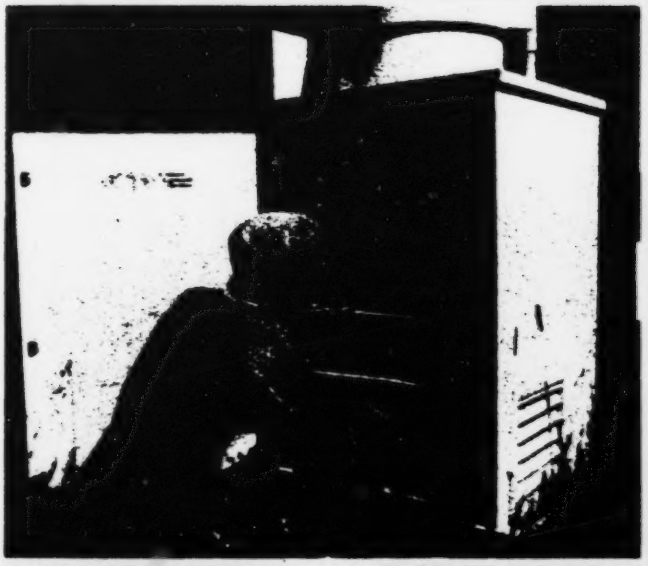
- The University of Calgary, Departments of Physics, Biology and Mathematics and Statistics;
- Ecosat Geobotanical Surveys Inc. Vancouver, British Columbia;
- Subsurface Technologies and Instrumentation Limited, Calgary, Alberta;
- Western Research, a division of Bow Valley Resource Services Ltd., Calgary, Alberta;
- Soils Department, Alberta Research Council; Edmonton, Alberta;
- Nuclear Environment Analysis Corp; Beaverton, Oregon;
- Element Analysis Corporation, Tallahassee, Florida;
- Lawrence Livermore Laboratory, University of California, Livermore, California; and
- University of Minnesota, Department of Plant Pathology, Minneapolis, Minnesota.



This simplified time line shows the progress to the end of fiscal year March 31, 1988.



This air monitoring station at Fortress Mountain measures Alberta's "background air quality." Meteorologists determined that the Fortress site is representative of air coming into Alberta from the West.



1

Researchers at Western Research, of Calgary, discuss air quality data.

2

As rain is a very unstable solution, ADRP researchers used a refrigerated rain sampler to collect samples for further analysis.

3 & 4

Researchers check on the equipment at the Crossfield air monitoring station. Rigorous quality control measures related to equipment performance and data collection ensured a high-quality data base. The ADRP's work represents some of the most comprehensive air monitoring done in the world.

5

The KAP Sampler, supported on this remote tower, provides a method of collecting nitric and nitrous acids for analysis, detects low concentrations of SO_2 over long periods and collects gases and fine particles without the uncertainty of chemical changes which can occur in traditional open-faced filter systems.

6

The University of Calgary's Kananaskis Centre for Environmental Research, the prime research contractor for the ADRP's biophysical work, developed the KAP Sampler or Kananaskis Atmospheric Pollution Sampler. The Sampler is an example of some of the state-of-the-art technology being used in the program. The researchers developed the KAP Sampler as available systems did not provide the accuracy and scope they require to thoroughly analyze the chemical composition of Alberta's atmosphere.

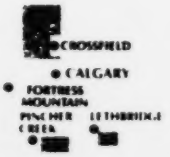
Sites of Biophysical Research and Human Health Research

MEDICAL DIAGNOSTIC REVIEW

BIOPHYSICAL RESEARCH

Biophysical

The research work at the Crossfield sites will include local and regional air quality assessments and agricultural crops and soils evaluation with respect to acidic deposition. The Fortress site is used as a "background" or comparison area, to determine the quality of air entering Alberta.



The Scientific Advisory Board approved the Crossfield site for this work for a number of important reasons:

1. The proximity to the large urban centre of Calgary, the major transportation corridor of Highway 2 north, local and regional industrial emissions and appropriate wind patterns, were key factors leading to Crossfield's selection.

2. At this site the researchers will be able to evaluate sulphur dioxide, hydrogen sulphide, hydrocarbons, oxides of nitrogen, ozone, carbon dioxide and trace metals. This evaluation will help researchers integrate ADRP's biophysical and health research programs by describing and quantifying the chemical nature of the atmosphere in Southern Alberta.

Human Health

The main study area, or Index Area, for the Medical Diagnostic Review (conducted in 1985-1986) included several communities near Pincher Creek, Alberta. An area southeast of Lethbridge, including Stirling/Raymond, and an area northwest of Calgary, including Crossfield, served as comparison communities in this major community health study.

Special Report – Communications and Public Involvement

As the scientific aspects of the Acid Deposition Research Program near "Critical Point 1," significant resources have been devoted towards communications planning. The ADRP has a commitment to public accountability and communication with the public. With this commitment to the public comes one of the major challenges facing many groups and associations: how to take extremely complex scientific information and "translate" it into forms that "non-scientists" will understand. Taking the challenge one step further, the ADRP also is striving to make the efforts of this scientific work relevant to Albertans.

The Public Advisory Board, as noted in the Members' Committee Report, has been working with the ADRP in areas of communications and relevance of the science and has provided advice, specific to the content of summary documents, audiences, and priorities in communications. Members have also worked to advise the groups they represent of the ADRP's goals and progress.

The following are some of the highlights in the ADRP's communications activities in 1987-88:

- Four meetings of the expanded Public Advisory Board were held.

- Two news conferences, one in Calgary, the other in Edmonton, were held to announce the publication of the world literature reviews and the air emission inventories. News releases, background materials for public information, and executive summaries were prepared and distributed to the ADRP's mailing list of 1,500, all members of Alberta's Legislature, and individuals nationally and internationally.

- Fourteen research publications were published, and registered with the National Library of Canada and specialized scientific data bases, such as the U.S. Department of Commerce National Technical Information Service. All Alberta libraries were provided with the overview reports, while full reports were provided to all Canadian universities, libraries and specialized environmental libraries. These reports were provided without charge, as were those provided to more than 500 Albertans, scientists and others requesting the materials.

- A full-page ad explaining the progress of the ADRP was taken in the special environmental issue of *Alberta Report*.

- Three **Updates**, ADRP's newsletter, were published.

- A variety of speaking engagements, conferences, seminars and workshops were attended focusing on the question of acid-forming gases.

- A public opinion poll was commissioned to assist the ADRP in its communications planning. Among the findings of this poll of 600 Albertans was that 91% of them expressed a great deal of interest in hearing about the results of the program. According to the researchers who conducted the poll, the sample is representative of Alberta's public. This and other data on the type of information Albertans would find valuable will help the ADRP in its communications.

The ARDP requested groups and associations interested in the topic of acid deposition and the environment to nominate representatives to the Public Advisory Board. Those representatives are (pictured from left to right, back row): **Dennis Gogal,** Environment and Outdoor Education Council, Alberta Teachers' Association; Moderator **Susie Washington**; **Dr. Dixon Thompson,** Science Advisory Committee, Environment Council of Alberta and Alberta Society of Professional Biologists and Canadian Society of Environmental Biologists; **Herman Bulten,** Christian Farmers Federation and other agricultural associations; **Prof. Eric Tollefson,** Association of Professional Engineers, Geologists and Geophysicists of Alberta; **Sam Sinclair,** Alberta Aboriginal Peoples; **Hank Gauthier,** Energy and Chemical Workers Union; (seated) **Dr. Lochan Bakshi,** Public Advisory Committee, Environment Council of Alberta, and **Dr. Nicholas Bayliss,** Alberta Health Care Associations.

ADRP Organization

A. Committees

Biophysical Technical Research Advisory Committee

Dr. John Railton, Chairman
Monenco Consultants Limited
(utilities group representative)

Randy Angle
Alberta Environment

Earle Baddaloo
Alberta Environment

Lin Callow
Gulf Canada Resources

David McCoy
Canterra Energy Ltd.

Technical Research Advisory Committee — Human Health

Dr. Linton Kulak, Chairman
Shell Canada Limited

Dr. Graham Gibbs
Alberta Community and Occupational Health

Ed A. Collom
Alberta Community and Occupational Health

Dr. Dennis Stokes
Alberta Environment

Communications Committee

Ed Brushett, Chairman
Energy Resources Conservation Board

Douglas Bruchet
Canadian Petroleum Association

Jean L. Andryiszyn,
Communications Co-ordinator

Susie Washington, Moderator,
Public Advisory Board

Dr. Ron R. Wallace, Program Manager

B. Scientific Advisory Board - Biophysical Research

Dr. Sagar V. Krupa, Chairman SAB
University of Minnesota
(Department of Plant Pathology)

Dr. C. M. Bhumralkar
National Oceanographic
and Atmospheric Administration (NOAA)

Dr. Herbert C. Jones
Tennessee Valley Authority
Fisheries and Aquatic Ecology Branch

Dr. Ron Kickert
Consultant (in modelling)

Dr. H. M. Liljestrand
University of Texas
(Department of Civil Engineering)

Dr. James P. Lodge
Consultant in Atmospheric Chemistry
and Editor, *Atmospheric Environment*

Dr. Douglas P. Ormrod
University of Guelph
Department of Horticultural Science

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U.S. Environmental Protection Agency

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Iowa State University
(Department of Agronomy)

Dr. T. Craig Weidensaul
Ohio Agricultural Research
and Development Center
Ohio State University

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Department of Medicine
University of New Mexico

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Co-Director
Pulmonary and Critical Care Unit
University of Rochester School of Medicine

D. Prime Research Contractors

Biophysical Research

Kananaskis Centre for
Environmental Research,
The University of Calgary

Principal Investigator:
Dr. Allan H. Legge

Medical Diagnostic Review

The McGill Inter-University
Research Group

Principal Investigator:
Dr. W.O. Spitzer

Occupational Health-Feasibility Study

Department of Health Services
Administration and Community
Medicine,
Faculty of Medicine,
University of Alberta

Principal Investigator:
Dr. Tee Guidotti

E. Members Public Advisory Board 1986-87

Moderator, Susie Washington

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Alberta Health Care Associations

Herman Bulten
Christian Farmers Federation and
other agricultural associations

Hank Gauthier
Energy and Chemical Workers Union

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Alberta Aboriginal Peoples

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University of Calgary
Science Advisory Committee
Environment Council of Alberta and
Alberta Society of Professional Biologists and
Canadian Society of Environmental Biologists

Prof. Eric Tollefson
University of Calgary
Association of Professional Engineers,
Geologists and Geophysicists of Alberta

Research Reports Published by the Acid Deposition Research Program

WORLD LITERATURE REVIEWS

ADRP Report Number	Microlog Number

☐ ADRP-B-01-87 88-00571/

Tetlang, S. A. 1987
Surface Water Acidification Literature Review. Prep for the Acid Deposition Research Program by the Kananaskis Centre for Environmental Research, The University of Calgary, Calgary, Alberta, Canada. 123 pp.
ISBN 0-921625-03-0 (Volume 1)
ISBN 0-921625-02-2 (Set of 11)

☐ ADRP-B-02-87 88-00572/

Visser, S., Danielson, R. M. and Parr, J. F. 1987
Effects of Acid-Forming Emissions on Soil Microorganisms and Microbially-Mediated Process. Prep for the Acid Deposition Research Program by the Kananaskis Centre for Environmental Research, The University of Calgary, Calgary, Alberta, Canada and U. S. Department of Agriculture, Beltsville, Maryland, U. S. A. 86 pp.
ISBN 0-921625-04-9 (Volume 2)
ISBN 0-921625-02-2 (Set of 11)

☐ ADRP-B-03-87 88-00573/

Krouse, H. R. 1987
Environmental Sulphur Isotope Studies in Alberta: A Review. Prep for the Acid Deposition Research Program by the Department of Physics, The University of Calgary, Calgary, Alberta, Canada. 89 pp.
ISBN 0-921625-05-7 (Volume 3)
ISBN 0-921625-02-2 (Set of 11)

☐ ADRP-B-04-87 88-00574/

Lanshley, E. J. and Bryant, R. 1987
Critical Review of Inorganic Sulphur Microbiology with Particular Reference to Alberta Soils. Prep for the Acid Deposition Research Program by the Department of Biology, The University of Calgary, Calgary, Alberta, Canada. 56 pp.
ISBN 0-921625-06-5 (Volume 4)
ISBN 0-921625-02-2 (Set of 11)

☐ ADRP-B-05-87 88-00575/

Turchenek, L. W., Abboud, S. A., Thomas, C. J., Fessenden, R. J. and Holowaychuk, N. 1987
Effects of Acid Deposition on Soils in Alberta. Prep for the Acid Deposition Research Program by the Alberta Research Council, Edmonton, Alberta, Canada. 202 pp.
ISBN 0-921625-07-3 (Volume 5)
ISBN 0-921625-02-2 (Set of 11)

ADRP Report Number	Microlog Number

☐ ADRP-B-06-87 88-00576/

Jaques, D. R. 1987
Major Biophysical Components of Alberta. Prep for the Acid Deposition Research Program by Ecosat Geobotanical Surveys Inc. 108 pp.
ISBN 0-921625-08-1 (Volume 6)
ISBN 0-921625-02-2 (Set of 11)

☐ ADRP-B-07-87 88-00577/

Campbell, K. W. 1987
Pollutant Exposure and Response Relationships: A Literature Review. Geological and Hydrogeological Aspects. Prep for the Acid Deposition Research Program by Subsurface Technologies and Instrumentation Limited, Calgary, Alberta, Canada. 152 pp. + maps.
ISBN 0-921625-09-X (Volume 7)
ISBN 0-921625-02-2 (Set of 11)

☐ ADRP-B-08-87 88-00578/

Torn, M. S., Degrange, J. E. and Shinn, J. H. 1987
The Effects of Acidic Deposition on Alberta Agriculture: A Review. Prep for the Acid Deposition Research Program by the Environmental Sciences Division, Lawrence Livermore National Laboratory. 160 pp.
ISBN 0-921625-10-3 (Volume 8)
ISBN 0-921625-02-2 (Set of 11)

☐ ADRP-B-09-87 88-00579/

Mayo, J. M. 1987
The Effects of Acid Deposition on Forests. Prep for the Acid Deposition Research Program by the Department of Biology, Emporia State University. 74 pp.
ISBN 0-921625-11-1 (Volume 9)
ISBN 0-921625-02-2 (Set of 11)

☐ ADRP-B-10-87 88-00580/

Krupa, S. V. and Kickert, R. N. 1987
An Analysis of Numerical Models of Air Pollutant Exposure and Vegetation Response. Prep for the Acid Deposition Research Program by the Department of Plant Pathology, University of Minnesota, St. Paul, Minnesota, U.S.A., and Consultant, Corvallis, Oregon, U.S.A. 133 pp.
ISBN 0-921625-12-X (Volume 10)
ISBN 0-921625-02-2 (Set of 11)

☐ ADRP-B-11-87 88-00616/

Legge, A. H. and Crowther, R. A. 1987
Acidic Deposition and the Environment: A Literature Overview. Prep for the Acid Deposition Research Program by the Kananaskis Centre for Environmental Research, The University of Calgary, Calgary, Alberta, Canada. 235 pp.
ISBN 0-921625-13-8 (Volume 11)
ISBN 0-921625-02-2 (Set of 11)

EMISSION INVENTORY

ADRP Report Number	Microlog Number

☐ ADRP-A-1-87 88-00581/

Picard, D. J., Colley, D. G. and Boyd, D. H. 1987
Overview of the Emission Data: Emission Inventory of Sulphur Oxides and Nitrogen Oxides in Alberta. Prep for the Acid Deposition Research Program by Western Research, Division of Bow Valley Resource Services Ltd., Calgary, Alberta, Canada.
ISBN 0-921625-18-9 (Volume 1)
ISBN 0-921625-17-0 (Set of 4)

☐ ADRP-A-2-87 88-00582/

Picard, D. J., Colley, D. G. and Boyd, D. H. 1987
***Design of Emission Inventory: Emission Inventory of Sulphur Oxides and Nitrogen Oxides in Alberta.** Prep for the Acid Deposition Research Program by Western Research, Division of Bow Valley Resource Services Ltd., Calgary, Alberta, Canada.
ISBN 0-921625-19-7 (Volume 2)
ISBN 0-921625-17-0 (Set of 4)

☐ ADRP-A-3-87 88-00583/

Picard, D. J., Colley, D. G. and Boyd, D. H. 1987
***Emission Data Base: Emission inventory of Sulphur Oxides and Nitrogen Oxides in Alberta.** Prep for the Acid Deposition Research Program by Western Research, Division of Bow Valley Resource Services Ltd., Calgary, Alberta, Canada.
ISBN 0-921625-20-0 (Volume 3)
ISBN 0-921625-17-0 (Set of 4)

☐ ADRP-A-4-87 88-00584/

Picard, D. J., Colley, D. G. and Boyd, D. H. 1987
***Results of the Emission Source Surveys: Emission Inventory of Sulphur Oxides and Nitrogen Oxides in Alberta.** Prep for the Acid Deposition Research Program by Western Research, Division of Bow Valley Resource Services Ltd., Calgary, Alberta, Canada.
ISBN 0-921625-21-9 (Volume 4)
ISBN 0-921625-17-0 (Set of 4)

*Detailed data compilations, of technical interest.

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Calgary, Alberta T2P 3Y7 (403) 269-6721

HUMAN HEALTH PROGRAM

Microlog Number

87-00668/10

Spitzer, W. O. and The McGill Interuniversity Research Group. 1986.
The Southwestern Alberta Medical Diagnostic Review, Volume One — Methodology. Prep. for the Acid Deposition Research Program by the Department of Epidemiology and Biostatistics, McGill University, Montreal, Quebec, Canada. 808 pp.
ISBN 0-921625-14-6 (Volume 1)
ISBN 0-921625-00-6 (Set of 4)

87-00668/10

Spitzer, W. O. and The McGill Interuniversity Research Group. 1986.
The Southwestern Alberta Medical Diagnostic Review, Volume Two — Results. Prep. for the Acid Deposition Research Program by the Department of Epidemiology and Biostatistics, McGill University, Montreal, Quebec, Canada. 542 pp.
ISBN 0-921625-15-4 (Volume 2)
ISBN 0-921625-00-6 (Set of 4)

87-00668/10

Spitzer, W. O. and The McGill Interuniversity Research Group. 1986.
The Southwestern Alberta Medical Diagnostic Review, Summary — Methods and Results. Prep. for the Acid Deposition Research Program by the Department of Epidemiology and Biostatistics, McGill University, Montreal, Quebec, Canada. 104 pp.
ISBN 0-921625-16-2 (Volume 3)
ISBN 0-921625-00-6 (Set of 4)

87-00668/10

Spitzer, W. O. and The McGill Interuniversity Research Group. 1986.
The Southwestern Alberta Medical Diagnostic Review, Appendix I — Supplementary Detailed Methods and Specific Results. Prep. for the Acid Deposition Research Program by the Department of Epidemiology and Biostatistics, McGill University, Montreal, Quebec, Canada.

87-00998/1

Burrows, B., Annau, Z., Samet, J. M., Hill, G., Mertz, W. and Utall, M. J. (Science Advisory Board, ADRP). 1986.
Final Report of the Science Advisory Board to the Medical Diagnostic Review Program. Prep. for the Acid Deposition Research Program. 31 pp.
ISBN 0-921625-01-4 (Volume 4)
ISBN 0-921625-00-6 (Set of 4)

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Financial Statement

Unaudited

Statement of Operations and Surplus

For the 12 Months from April 1, 1987 to March 31, 1988

	1988
Revenue:	
Surplus, March 31, 1987	$ 72,979
Members	1,192,878
Interest	22,449
	$1,288,306
Expenditures	
Biophysical	1,321,274
Communications	194,597
Administration	170,929
	$1,686,800
Excess (Deficit) revenue over expenditures for the period and deficit at end of period	**$ (398,494)**

Balance Sheet

March 31, 1988

	1988
Assets:	
Current	
Cash and short-term deposits	$216,343
Accounts Receivable	140,000
	$356,343
Liabilities and Surplus (Deficit)	
Current	
Accounts Payable	$754,837
Surplus	(398,494)
	$356,343

Notes to Financial Statements

March 31, 1988

1. Operations and significant accounting policies

The Acid Deposition Research Program was established on January 1, 1983 to perform studies and conduct various workshops and other activities on behalf of its members who are principally companies and organizations operating in the natural resources and energy sectors. The majority of the Program's revenue is derived from, and expenditures are incurred on behalf of, its members.

The financial statements of the Program have been prepared by management in accordance with accounting principles that are considered appropriate for organizations of this nature. The financial statements have, in management's opinion, been properly prepared within reasonable limits of materiality and within the framework of the accounting policies summarized below.

a) Revenue

The Program accounts for revenues using the accrual method of accounting except that interest earned on surplus cash is recognized on the cash basis.

b) Income tax status

The Program is a non-profit organization and as such is exempt from income tax.